

No. 6.—*Reports on the Scientific Results of an Expedition to the Southwestern Highlands of Tanganyika Territory*

VI

*Parasitic Nematodes from East Africa and Southern Rhodesia*

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This report is based on material secured by Mr. Arthur Loveridge of this museum on the occasion of his recent zoölogical collecting expedition to Tanganyika Territory, and on a collection made by the author incidental to the prosecution of certain special helminthological studies in Southern Rhodesia and Mozambique (Portuguese East Africa) at about the same time. The report is restricted in its scope to the nematodes, of which nine new species are here described. The parasitic worms of other groups will be made the subject of later studies.

Preceding the systematic descriptions of the new forms, it has been thought worth while to give a list of other nematodes identified in this collection adequate descriptions of which are already available, which extends either the host or geographic ranges of species. In some instances, owing to an unfortunate insufficiency of material, only the generic identification of the parasites has been possible.

The author desires to record his appreciation to Mr. Loveridge for the opportunity of studying his collection and to Messrs. Glover M. Allen, Outram Bangs and James L. Peters for their kind services in the authoritative identification of the bird and mammalian hosts of the parasites.

The type specimens of the new forms described are deposited in the helminthological collection of the Museum of Comparative Zoölogy, Cambridge, Mass.

MAMMALIA

Primates

*Cercopithecus leucampyx moloneyi*

Tanganyika *Oesophagostomum pachycephalum*  
*Streptopharagus pigmentatus*

*C. l. beirensis*

S. Rhodesia " "  
*Trichiurus trichiura*  
*Oesophagostomum brumpti*

*C. aethiops pygerythrus*

Mozambique " "

*C. aethiops centralis*

Tanganyika " "

*Colobus badius gordonorum*

" "  
*pachycephalum*

*Papio (neumannii?)*

" "  
*Streptopharagus pigmentatus*  
*Physaloptera caucasica*

<i>Papio porcarius</i>	S. Rhodesia	<i>Streptopharagus pigmentatus</i> <i>Oesophagostomum brumpti</i> <i>Strongyloides fulleborni</i>
Cheiroptera		
<i>Rhinolophus augur zambesiensis</i>	"	<i>Strongylacantha glycirrhiza</i>
Carnivora		
<i>Thos adustus</i>	"	<i>Ancylostoma braziliense</i> " <i>caninum</i>
<i>Felis capensis hindei</i>	Tanganyika	<i>Toxocara mystax</i> <i>Physaloptera praeputiale</i>
Insectivora		
<i>Crocidura nyanzae kivu</i>	"	<i>Amplicaecum</i> sp. (encapsuled larvae)
Hyracoidea		
<i>Procavia brucei frommi</i>	"	<i>Crossophorus collaris</i> <i>Hoplodontophorus flagellum</i> <i>Theileriana brachylaïma</i> <i>Setaria loreridgei</i>
<i>Pedetes dentatus</i>	"	<i>Trichuris</i> sp
<i>Mastomys microdon victoriae</i>	"	<i>Protospirura muricola</i>
<i>Tatera lobengulae</i>	S. Rhodesia	" "
<i>Leggada minutoides</i>	"	" "
<i>Otomys irroratus</i>	"	" "
<i>Cricetomys gambianus</i>	"	<i>Heterakis spumosa</i>

## AVES

Accipitriformes		
<i>Falco biarmicus biarmicus</i>	Tanganyika	<i>Dispharynx</i> sp.
<i>F. s. subbuteo</i>	"	<i>Habronema leptoptera</i>
<i>Elanus caeruleus</i>	S. Rhodesia	" "
<i>Circus cinereus</i>	"	<i>Physaloptera alata</i> <i>Porrocaecum depressum</i>
Galliformes		
<i>Guttera edwardi</i>	"	<i>Ascaridia numidia</i> <i>Heterakis brevispiculum</i>
<i>Francolinus coqui hubbardi</i>	Tanganyika	<i>Heterakis</i> sp.
<i>Pternistes cranchii itigi</i>	"	<i>Porrocaecum</i> sp.

## REPTILIA

Lacertilia		
<i>Agama agama turnensis</i>	Tanganyika	<i>Strongyluris gigas</i> <i>S. ornata</i> (?) <i>S. ornata</i> (?)
<i>A. atricollis</i>	"	<i>S. brevicaudata</i>
<i>Chamaeleon goetzei</i>	"	"
<i>Chamaeleon tempeli</i>	"	"

<i>Mabuya planifrons</i>	Tanganyika	<i>Physaloptera</i> sp.*
<i>Gerrhosaurus major zechi</i>	"	"
<i>Varanus niloticus</i>	"	<i>Tanqua tiara</i>
Ophidia		
<i>Typhlops punctatus punctatus</i>	"	<i>Kalicephalus</i> sp.*
<i>Boacdon lineatus</i>	"	"
<i>Grayia tholloni</i>	"	"
<i>Trimerorhinus tritaeniatus</i>	"	"
<i>Psammophis sibilans</i>	"	"
<i>Naja melanoleucus</i>	"	"

## AMPHIBIA

<i>Rana mascareniensis</i>	S. Rhodesia	<i>Amphibiophyllus acanthocirrat- us.</i>
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## Superfamily TRICHUROIDEA

## Family TRICHURIDÆ

## Subfamily Capillariinae

## HEPATICOLA HEPATICA (Bancroft, 1893)

Hosts: *Acomys selousi*, and (?) *Homo sapiens*.

Locality: Mount Silinda, Southern Rhodesia.

At present four species are recognized in the genus *Hepaticola*, on which considerable interest has recently been focussed because of the report of an authentic case of infection with *H. hepatica* in man. (MacArthur, 1924 and later reports of several human infections in Russia and Panama.)

The type species, *H. hepatica*, is a relatively long, very fragile worm which lives in the tissue of the liver, primarily of mice, rats, the hare and, in this country, also the coyote. *H. hepatica* enjoys a cosmopolitan distribution coincident with that of its rodent hosts. When the number of worms is high, as it frequently is, considerable destruction of liver tissue occurs with consequent pathological sequelae. Other species that have been described are: *H. soricicola* Nishigori, 1924 from the liver of *Sorex* sp. in Formosa; *H. anthropithici* Trosier et al., 1928, from the liver of the Chimpanzee in West Africa; *H. gastrica*

\*Because of the considerable variation found associated with the so-called specific characters, many of the large number of species that have been proposed in the genera *Kalicephalus* and *Physaloptera* are indistinguishable. I consequently refrain from attempting specific identification of the reptilian representatives of these genera pending more comparative material which will make a critical study possible.

Baylis, 1926, from the stomach of *Rattus norvegicus* and *R. rattus* in Europe; *H. muris* Uyeyama, 1928, from the stomach of *Epimys (Rattus) norvegicus* in Japan.

The morphology of *H. hepaticola*, as well as that of the other species, is rather imperfectly known since even by the most careful dissection it is difficult to extract the fragile sinuous worms from the matrix in which they are intimately embedded. For morphological study usually little more can be secured than fragments of the anterior and posterior parts of the body.

To add to the difficulty of classification, the male worm, which possesses the most important taxonomic characters, is found even less frequently than the female. In consequence of this, the various species established have been based on a presumable specificity of habitat of the worm and certain characteristics of the egg.

In our case, the specific identification has been based primarily on size of eggs, and their comparison in structure and shape with eggs of *H. hepaticola* secured from *Rattus norvegicus* in Boston. The variation in size was found to be from 52 to 58 $\mu$  by 27.6 to 29 $\mu$ , a figure which falls very well within the relatively extensive range reported by others.

*Hepaticola hepatica* was found to be very prevalent among field mice at Mount Silinda, the livers frequently being massively infected in all their lobes. Attempts to dissect out entire worms yielded disappointing results.

As has been well established by many workers, the eggs of *Hepaticola hepatica* are usually well walled off by adventitious connective tissue in the liver, and are not released from this organ before the death of the host. Only on rare occasions have they been found in small numbers in the intestinal contents and faeces. Considerable interest from the standpoint of tropical medicine, consequently attaches to our finding a very rich supply of eggs indistinguishable from *H. hepatica* in a stool from a single individual out of several hundreds examined at Mt. Silinda. The individual, a woman of the Ndau tribe, neither displayed symptoms, nor gave any history of any previous illness that might be attributable to a massive *Hepaticola* infestation. By the time that the anomaly of finding the stool heavily laden with the eggs of *H. hepaticola* was realised, the woman, who was a visitor in this neighborhood, had gone away and no further stools could be secured.

In view of the propensity of African natives to consume various forms of rodent life among which rats, porcupines and squirrels may be specifically cited as evidenced by our own observation, it is highly probable, in our opinion, that human cases in which the *Hepaticola*

eggs are found in the stools may be relegated to the growing category of pseudo-parasitism in which eggs found in faeces represent innocent passengers through the human alimentary canal. The helminthological examination of the faeces over several days, when the diet of the patient is controlled, would establish the correctness of this surmise.

Superfamily STRONGYLOIDEA  
 Family TRICHOSTRONGYLIDAE  
 Subfamily Trichostrongylinae  
 HAEMONCHUS LAWRENCEI sp. nov.

Host: *Cephalophus monticola*.

Locality: Mt. Silinda, Southern Rhodesia.

Scrapings of the mucosa of the small intestine, more especially the duodenum of a blue duiker, caught in the rain forest at Mt. Silinda, brought to light an infection with minute colorless nematodes. Later examination of the material, which was fixed in formalin, showed the infection to be a multiple one, involving two, as yet undetermined, species of the genera *Trichostrongylus* and *Cooperia*, and a species of the genus *Haemonchus*, which we think has not previously been described and for which we propose the name *Haemonchus lawrencei* in honor of Dr. W. T. Lawrence of the Mount Silinda mission.

The more important measurements of *H. lawrencei* are given in millimeters in the accompanying table:

	<i>Female</i>	<i>Male</i>
Total length	10.6–11.56	7.6–9.9
Maximum breadth	0.32	0.24
Length of Oesophagus	1.0–1.07	0.96–0.98
Antr. end to excr. pore	0.21	0.22–0.27
Antr. end to cervical pap.	0.3–0.35	0.29
Vulva to postr. end	0.147 to 0.155	
Anus to postr. end	0.035 to 0.377	
Eggs	0.065 x 0.038 to 0.082 x 0.043	
Gubernaculum	} Measured on dissected	0.150–0.160
Spicules		
Distance of barbs to tip of spicules		0.340–0.36
		0.029–0.035 (1st)
		0.061–0.066 (2nd)

The worms, of which we have carefully examined more than twenty examples and compared with the type species *Haemonchus contortus*

from various hosts, besides being definitely smaller than any of the species previously described in the genus, may be readily distinguished from all others except *H. vegliai* LeRoux by the presence, on both right and left spicules, of a barb-like prominence some distance from the normal terminal barb.

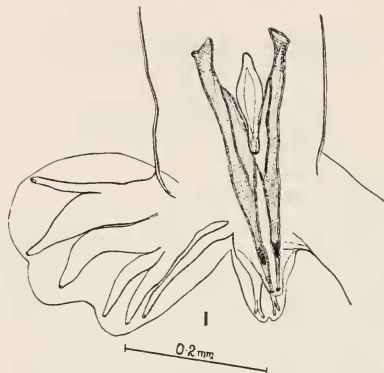


Fig. 1. *Haemonchus laurencei*, n. sp. Ventral view of bursa showing bursal lobes and rays of one side, genital cone, spicules and gubernaculum.

It apparently is also to be contrasted with other species in the genus in that the dorsal lobe of the bursa (fig. 1) is symmetrical with respect to the two lateral lobes and does not take origin from the base of the left lateral lobe. Aside from these points, the morphology of the parasite is characteristic of the genus. Incidentally it may be noted that, while in the majority of female specimens the vulva is provided with a salient linguiform process, in other specimens, although these are mature and gravid, the vulva has no conspicuous lips. This observation brings further support for the view expressed by several authors to the effect that the presence or absence of a linguiform process cannot be legitimately used as a specific criterion and hence, insofar as this feature is stressed, the validity of *H. cerrinus* Baylis and Daubney 1922, and of *H. similis* Travassos 1914, is doubtful.

#### AFFINITIES

The size range of *H. laurencei* is distinctly smaller than that described for other species, and similar relatively diminutive dimensions

apply to the various organs of the body. Because of variation within the species in this genus, the size criterion, if it can be used at all, must be applied with caution as a specific character. The length of the spicules within limits, however, appears to be constant in specimens of different size, and Le Roux (1929, p. 452) asserts the value of the spicule

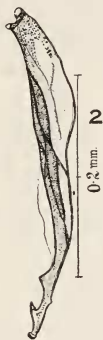


Fig. 2. *Haemonchus laurencei*, n. sp. Isolated left spicule magnified.

characteristics, more especially the position of the barbs, in distinguishing the various species. The possession of two barbs on the spicules is a character shared apparently only with *H. veglii* (Le Roux 1929) but size of the gubernaculum and total length of the spicules seem to be sufficient to establish the distinction between these two species.

#### Family ANCYLOSTOMIDAE

##### Subfamily Necatorinae

#### NECATOR AMERICANUS (Stiles, 1902)

Host: *Papio porcarius*.

Locality: Near Mt. Silinda, Southern Rhodesia.

A single male specimen of the genus *Necator*, approximately 9 mm. in length, was found attached to the wall of the duodenum of one of seven baboons shot in this locality. The genus has, to my knowledge, never before been recorded from the baboon, although two species, namely *N. cxilidens* Looss, 1912 and *N. congolensis* Gedoelst, 1916

have been described from the Chimpanzee. *N. americanus*, the species that commonly parasitises man, has, however, been recorded from the gorilla. A large porportion of the natives in this region are infested with *N. americanus*, and for this reason the specimen found in the baboon is attributed to the same species, it being well known that certain parasites which have chanced to invade a host only partially suitable for their development will be stunted in their growth. Aside from the general dwarfing, the specimen from the baboon could not be distinguished from specimens of *Necator americanus* of human origin.

### Superfamily OXYUROIDEA

#### Family OXYURIDAE

##### Subfamily Oxyurinae

##### SYPHACIA PARAXERI sp. nov.

Host: *Paraxerus palliatus*.

Locality: Mt. Silinda, So. Rhodesia.

Numerous specimens of a typical species of *Syphacia* were examined from this host. The male possesses only two cuticular mamelons, a character shared with only two previously described species of the genus, namely *S. pallaryi* Seurat, 1915 from *Xerus getulus* and *S. pearsi* Baylis, 1928 from *Heliosciurus isabellinus*.

In the accompanying table the principal morphological measurements (in millimeters) of these two species are set down for comparison with those of the species here described.

As will be seen from the above measurements *S. pallaryi*, *S. pearsi* and *S. paraxeri* are closely related. They do not appear to exhibit any differences in morphology. Aside from size criteria, which in our material do not show great variations, *S. paraxeri* and *S. pearsi* are to be readily distinguished from *S. pallaryi* by the posterior position of the vulva relative to the end of the oesophagus and also by the relative positions of the two mamelons, the anterior mamelon in *S. pallaryi* being in the middle of the body while in *S. paraxeri*, as in *S. pearsi*, both mamelons are situated nearer the cloacal region. *S. paraxeri* may be differentiated from *S. pearsi* by the relative size of the body of both sexes, distinctly smaller eggs, tail and spicules. Like *S. pearsi*, the gubernaculum of *S. paraxeri* appears, even under the highest magnification, to be devoid of a terminal barb-like hook such as is noted in *S. palaryi* and *S. thompsoni* Price, 1928.



	<i>S. pallaryi</i>		<i>S. pearsi</i>		<i>S. paraxeri</i>	
	♂	♀	♂	♀	♂	♀
Length	2.0	2.9	1.9-2.0	3.2-4.0	1.6-1.7	4.6-5.3
Max. breadth	0.18	0.275	0.13	0.24	0.096	0.220-0.260
Length of oesophagus (including bulb)	0.40	0.43	0.34-0.36 (-1/5)	0.380-0.480 (ca. 1/7)	0.220-0.230 1/7	0.330 1/14
Ratio of oesophagus Vulva from antr. end	1/6	1/5		0.70-0.850		0.63-0.82
Length of tail	0.13	ca. 0.5	0.18-0.23	0.70-0.850	0.12-0.13	0.59-0.70
Size of eggs		ca. 0.5		0.100 x 0.037		0.081-0.087 x 0.029-0.032
Length of spicule	0.084	0.084 x 0.025	0.130		0.072-0.076	
Length of gubernaculum	0.055		0.070		0.047-0.050	

## Family HETERAKIDAE

## Subfamily Heterakinae

## HETERAKIS SILINDAE, sp. nov.

Host: *Pternistis afer swynnertoni*.

Locality: Mt. Silinda, Southern Rhodesia.

The new species described below is based on some twenty male and female worms found in the rectal caeca of the red-necked francolin of Mashonaland.

The worms are rather slender in build. The anterior extremity is gently curved dorsally and the body tapers gradually from about its middle point to a finely drawn tail. The three dome-shaped lips are relatively large with small but prominent subapical papillae. Lateral alae, that arise near the head on either side, reach their greatest width, 0.074 mm., at the level of the middle of the oesophagus and extend along the anterior third of the body.

The principal measurements of the organs, tabulated below, together with the diagram illustrating the arrangement of papillae and other structures at the caudal extremity of the male should suffice for the recognition of the species.

	<i>Male</i>	<i>Female</i>
Total length	9-10.5	11-12.5
Maximum width	0.41	0.43
Pharynx	0.074	0.074
Oesophagus (including bulb)	1.07	1.25
Tail	0.53	0.96
Nerve ring from antr. end.	0.37	0.39
Excretory pore from antr. end.	0.51	0.53
Vulva from antr. end.		6.25
Eggs		0.066 x 0.040

In the male the sucking disc, situated from 0.18 to 0.20 mm. in front of the cloaca, measures 0.095 mm. in diameter, including the wide outer rim.

The spicules are spike-like with large heads and thick tapering shafts. They are equal in size, measuring 0.44 to 0.46 mm. in length.

There are thirteen pairs of ventral caudal papillae. The first pair of these are small but readily detected in ventral view and are situated some distance in front of the sucker, just behind the heads of the spicules. The remaining twelve posterior pairs of papillae are distributed in the normal manner as exemplified in the type and certain other species of the genus and as figured in the accompanying diagram.

Among other characters of minor importance, it is the constant possession of the anteriorly situated pair of papillae that serves to distinguish

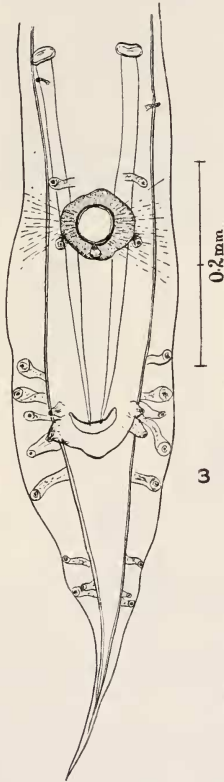


Fig. 3. *Heterakis silindae*, n. sp. Caudal extremity of male; ventral view.

*H. silindae* from other species of the genus which have thirteen pairs of caudal papillae, such as *H. beramporia* Lane, 1914, *H. bonasae* Cram, 1927, etc.

## STRONGYLURIS PARADOXUS, sp. nov.

Host: *Hagedashia hagedash nilotica* (Glossy Ibis)

Locality: Mwanza, Tanganyika Territory.

Eight specimens of an Oxyuroid that must be referred to the genus *Strongyluris* Müller, 1894, were found in the same vial with material described below as *Contracaecum hagedashiae*, n. sp.

Since these worms conform in all particulars with the definition of the genus, there is no need of a detailed description. It is probable that the measurements of the chief morphological features given in tabular form below and diagrams of the male and female caudal extremities will suffice for their recognition.

	<i>Male</i>	<i>Female</i>
Length*	11.-11.5	11.2-12.3
Maximum breadth	0.6- 0.65	0.70
Height of lips	0.042	0.043
Pharynx	0.22	0.26
Oesophagus	1.85	2.0
Tail	0.12	0.25
Diameter of sucker	0.105	
Sucker from postr. extremity	0.127	
Vulva from postr. extremity		4.1-4.4
Caudal papillae postr. extremity		0.090
Spicules	1.1-1.2	
Eggs		0.065-0.071 x 0.040-0.047

We have closely compared the material with the following species of *Strongyluris* from East and West Africa in our collection: *S. brevicaudata* Müller from *Agama* spp. *Mabuya* spp. and *Chamaeleon* spp., *S. gigas* Spaul from *Agama agama dodomae*, and *S. (?) ornata* Gendre from *Agama atricollis* and find that, in general appearance and details of structure, it most closely resembles *S. brevicaudata* as this species is understood by Taylor (1924). Our form differs from other species in the genus in that there are 8 pairs of caudal papillae instead of the usual 10 pairs. There is only a single pair of sessile, median, post-anal papillae and but two pairs of slender stalked papillae in the terminal caudal region, in place of the two and three pairs of papillae that regularly are found respectively in these situations.

Aside from the number of papillae, *S. paradoxus* is distinguishable

\*All measurements are in millimetres.

especially from *S. brevicaudata* in that the caudal alae in the male are reduced to a mere vestige discernable only when the worm is seen from the lateral aspect.

The several species of the genus *Strongyluris* have hitherto been recorded exclusively from lacertilians. This is the first time that it is

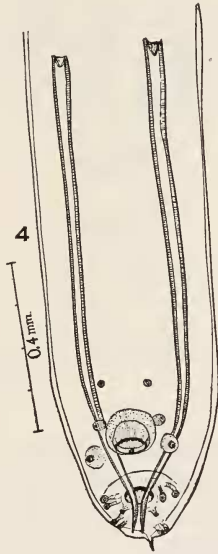


Fig. 4. *Strongyluris paradoxus*, n. sp. Caudal extremity of male; ventral view showing distribution of papillae.

reported from a bird. Had there not been specimens of the typically avian genus *Contracaecum* in the same vial, there might be strong grounds for suspecting a mislabelling of the host. Mr. Loveridge, however, assures me that such a confusion is not likely. Another possible explanation for such an unusual host relation is that the parasites represent the undigested remains from a lizard previously eaten by the host. This likewise seems improbable, since *Hagedashia hagedash* is a

wading bird, feeding, so far as is known, on aquatic food found in the muddy bottoms of the shallow streams that it frequents, where lizards



Fig. 5. *Strongyluris paradoxus*, n. sp. Caudal extremity of male; lateral view showing distribution of papillae.

are not likely to occur. It may be mentioned that our material is in a fine state of preservation indicating that the parasites were living at the time of fixation.

## Family SUBULURIDAE

### Subfamily Subulurinae

#### SUBULURA CALLOSA, sp. nov.

Host: *Petrodromus tetradactylus*.

Locality: Mt. Silinda, Southern Rhodesia.

The only nematodes found in three elephant shrews examined in this locality were two males of an Heterakid genus recovered from the large intestine. In so far as the worms do not entirely conform to the generic definition of what appears to be their closest relatives, we think it best to identify them provisionally with the genus *Subulura sensu lato*.

The worms are creamy white in color; body straight with posterior extremity curved slightly in ventral direction. They measure 7.8 mm. and 8.2 mm. with maximum breadth (near the middle of the body) of 0.54 and 0.62 mm. respectively. Body tapers to an obtuse anteriorly

directed mouth. Posterior to the cloaca there is a rapid tapering to an acutely pointed conical tail. There are a pair of translucent lateral cervical alae  $36\mu$  at their widest point which commence at the head and extend as far as the middle of the anterior cylindrical portion of the oesophagus where it disappears insensibly into the dense cuticle which covers the remainder of the body. This cuticle, which is extraordinarily thick ( $25\mu$ ), shows an exceedingly fine striation in addition to a superimposed corrugation or broad annulation. Lateral cervical papillae are not discernable. The mouth,  $60\mu$  wide, is limited laterally by apparently two indistinct lips provided each with three papillae of which the lateral are more massive than the submedian. There is a well developed buccal cavity,  $50\mu$  deep, characteristically divided into

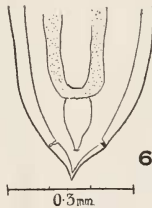


Fig. 6. *Strongyluris paradoxus*, n. sp. Caudal extremity of female; ventral view showing lateral papillae.

an upper compartment about  $25\mu$  broad and  $30\mu$  deep with heavily cuticularised walls, and a lower infundibuliform chamber, from the base of which there project three massive blunt teeth. The oesophagus, measuring 0.88 mm. in length, is divisible into two well-defined parts. The anterior part, with thick muscular walls, is club-shaped and its broad base is constricted off into a narrow isthmus that connects it with a spherical bulb, 0.21 mm. wide, provided with cuticularised valves. The intestine is straight and opens through a well-defined rectal portion at the cloaca about 0.23 mm. from the extremity of the tail. An ampulliform cloacal gland may be seen at the side of the rectum discharging apparently into the cloacal cavity. The cloacal aperture is spacious but there are no salient cloacal lips. Caudal alae absent. Some 0.67 mm. in front of the cloaca is a massive sucker practically circular in outline (0.154 mm. diameter) with a "chitinous" rim nearly  $30\mu$  wide. There are 8 pairs of stalked caudal papillae. The first pair are large and parasuctorial in position. The second pair also

large, are a little more than half way toward the cloaca. The third pair are smaller and just precloacal in position. The fourth and fifth pairs of papillae are large and disposed side by side at the level of the cloaca. The sixth, seventh and eighth pairs of papillae grow progressively smaller. (See fig. 6.)

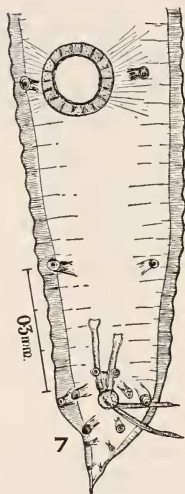


Fig. 7. *Subulura callosa* n. sp. Caudal extremity of male; ventral view.

The spicules are similar and seemingly equal in length. The proximal end is slightly dilated; the shaft is of uniform width ( $18\mu$ ) and the distal pointed ends bear a narrow membranous expansion. The length of the spicules is  $440\mu$ . The gubernaculum as seen from the side is more or less awl-shaped with a broad head and pointed distal end. It measures  $140\mu$  in length.

*Systematic Affinities.* It is in relatively recent times that the multiplicity of species formerly attributed to the extensive genus *Heterakis* have been divided up and distributed among two families,—the



Heterakidae, Railliet and Henry, 1914, and the Subuluridae, Yorke and Maplestone, 1926, distinguished chiefly by the presence of three well-defined lips, a simple pharynx without teeth and a circular chitin-bound preanal sucker in the male of the Heterakidae, and ill defined lips, a buccal vestibule with teeth in its base, and an elongate pseudo-sucker in the male of the Subuluridae. There is no question but that this division has, in the main, been practical, and taxonomically convenient. The presence of a well-developed preanal sucker with a strong chitinous rim in material described in the present paper would require its classification with the Heterakidae but otherwise its morphology especially of the buccal cavity proclaims it a very typical member of the Subuluridae. Aside from the presence of a circular preanal sucker with a chitinous rim and the fact that the left spicule is equal in size and in the extent of its chitinization with the right, the form may be regarded as congeneric with the genus *Numidica*. Baylis (1930) has brought out that the distinction between the genera *Numidica* and *Oxynema* is a dubious one, and it is questionable whether a generic distinction between *Numidica* and *Subulura* is entirely justifiable. In consequence of this, rather than to create a new genus we have referred our specimens to the genus *Subulura*, the diagnosis of which will accordingly require emendation. However, it appears desirable to defer such an action until the female of *S. callosa* is available to complete the study. The species, which we have here described, increases the doubts raised by Baylis and at the same time affords an interesting connecting link, at least so far as presented by the morphology of the male, between the genera *Heterakis* and *Subulura*.

### Superfamily ASCAROIDEA

### Family HETEROCHEILIDAE

### Subfamily Anisakinae

### CONTRACAECUM HAGEDASHIAE, sp. nov.

Host: *Hagedashia hagedash nilotica*.

Locality: Mwanza, Tanganyika Territory.

Although more than 20 specimens of the species are at hand, it is not possible to give a complete description since the females, while having the sexual organs developed, have not attained full maturity. For the most part, the worms are enveloped in a triple layer of cuticle, which no doubt represent the unshed cuticles of the third and fourth larval

stages. By stripping off these coverings, the caudal papillae of the males are plainly discernable, and it is on the assumption that these structures constitute the full complement of the adult worm that the species is described as new. Because of the relative immaturity of the material, all measurements must be regarded as minimal ones subject to a further accretion before the fully mature condition is attained.

The worms are creamy white in color with a deep transverse striation of the cuticle. The lips, three in number, are more or less quadrangular in shape and are set off from the body of the worm by a shoulderlike annular constriction. (Fig. 7.) The interlabia narrow

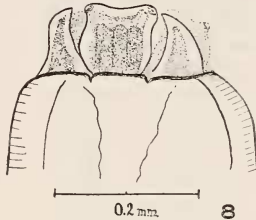


Fig. 8. *Contracaecum hagedashiae*, n. sp. Cephalic extremity.

from the base upwards and curve inwards between the lips. The length of male and female specimens is up to 34 mm. and 43 mm. respectively. In the largest females the oesophagus is 9.1 mm. long. In another female specimen, about 40 mm. long, the oesophagus measures only 3.4 mm. Such a striking variation in the relative length of this organ is seldom recorded and indicates the caution that must accompany the use of this ratio for purposes of taxonomy. The anteriorly directed intestinal caecum is about two-thirds of the length of the oesophagus. The posterior appendix measures from 0.89 to 1.25 mm. in length. The vulva opens inconspicuously on the external surface 12.5 mm. from the anterior end in the largest specimen. The posterior extremity tapers gradually to an acute point. The anus is subterminal, 0.08 mm. from the extremity. As already stated, none of the females are gravid.

The tail of the male is conoid in shape. The anus opens 0.12 mm. from the extremity. There are at least 65 pairs of minute preanal papillae extending along the sublateral field to a point 3.2 mm. anterior

to the cloaca. There are a pair of papillae on each side in the adanal position. Postanally there are six pairs of papillae, (including one papilla that has a double appearance) on each side of the tail (Fig. 9). The spicules are equal in length and measure 1.25 mm. with a breadth of 0.025 mm. No trace of a gubernaculum was found.

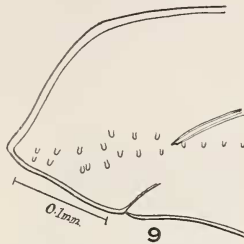


Fig. 9. *Contracaecum hagedashiae*, n. sp. Caudal extremity of male showing papillae.

This species may be distinguished from all previously described avian members of the genus by the characteristic arrangement of the postanal papillae and the unusually large number of preanal papillae in the male.

#### DUJARDINIA, sp. indet.

Host: *Myonax grantii*.

Locality: Kigogo, Tanganyika Territory.

The material consists of four females and several small larvae and is, unfortunately, not in a satisfactory condition to make specific identification possible. The genus, which is readily identified by the structure of its oesophagus, has previously been recorded from fishes, reptiles and marine mammals (Dugong). It may consequently be a foreign or spurious parasite in the mongoose, where its presence is to be accounted for as the undigested remains of a previously consumed reptile.

#### AMPLICAECUM INVOLUTUM (Geddoelst, 1916)

Hosts: *Bufo regularis* and *Dispholidus typus*.

Locality: Mt. Silinda, Southern Rhodesia.

In addition to a small infection found in *Bufo regularis*, the type host of *A. africanum* Taylor, 1924, the same species of parasite was found in

large numbers in *Dispholidus typus*, a colubrine snake. The genus has previously been recorded from Amphibia, Lacertilia and Aves. The present is apparently the first record from the Ophidia. Khalil has recently (1926) tabulated the main characters of the species of this genus. From his table it is apparent that *A. africanum* is very closely related to *A. involutum*, a species apparently overlooked by Taylor. The main differences that could be used to separate *A. africanum* from *A. involutum*, as these species have been described, are slight differences in the spicule length and the presence in *A. africanum* of a single pre-anal papilla. This papilla is not present in material from either of our hosts and the length of spicules (0.765–0.98 mm.) covers the range of both Gedoelst's and Taylor's species. They are apparently the same form, and on grounds of priority *A. africanum* should, in our opinion, be placed in the synonymy of *A. involutum* (Gedoelst) Yorke and Maplestone.

### Superfamily SPIRUROIDEA

#### Family SPIRURIDAE

#### Subfamily Arduenninae

#### ARDUENNA AFRICANA, sp. nov.

Hosts: *Mastomys (Epimys) microdon victoriae* — Rungwe Mt., Tanganyika.  
*Rhabdomys pumilio diminutus*, Dabaga, Uzungwe Mtns. Tanganyika.  
*Boaedon lineatus* — Unyanganyi, Turu, Tanganyika.

The numbers of specimens derived from the three sources indicated above are respectively, 16, 7 and 18. Despite careful search for constant differences of a significant order in this material, we have failed to detect anything that would warrant its being considered as representing more than one species. On general principles, however, it seems probable that *Boaedon lineatus* is not a true host of the parasite, its presence in the snake being explainable on the assumption that the worms represent the undigested residue from the true host previously consumed by the reptile. On the other hand, it may be noted that the specimens from the snake are in as good a condition of preservation as are those from the rodent sources.

The following description covers the material from the three hosts mentioned above:

Specific diagnosis: Arduenna of relatively large size with the characters of the genus.

The cuticle is finely annulated by striations  $7\mu$  apart. Cervical papillae acicular, exceedingly minute and difficult to find. In male specimens, they were observed asymmetrically disposed, the right papilla at the level of the nerve ring, the left  $105\mu$  to  $140\mu$  anterior to this point. In favorably mounted specimens a very narrow cervical ala may be seen on the left side arising immediately behind the cervical papilla and extending about half the length of the oesophagus.

The mouth opening is bounded dorsally and ventrally by two trilobed lips guarded by the usual pair of fine teeth which arise from the anterior edge of the pharyngeal walls.

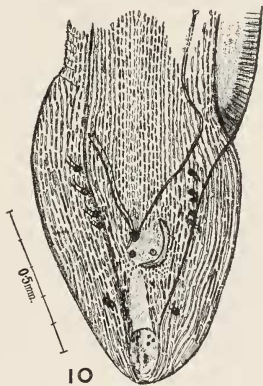


Fig. 10. *Arduenna africana*, n. sp. Caudal extremity of male. Ventral view. Specimen from *Mastomys microdon victoriae*.

The pharynx, with spiral markings, measures  $110\mu$  in smaller specimens to  $147\mu$  in the largest; it is from  $41$  to  $44\mu$  wide with walls about  $11\mu$  thick. Its base is marked by an annular ring about  $15\mu$  wide.

The oesophagus is composed of a narrow, anterior portion, about  $0.35$  mm. long, and a wider glandular portion posteriorly. In the female the entire oesophagus measures from  $2.3$  mm. to  $3.5$  mm. in length, this being from  $1/8$  to  $1/11$ th of the body length. In the male, the oesophagus is relatively shorter, being on the average  $1/6$ th of the total length.

The nerve ring encircles the oesophagus near the junction of its anterior and posterior divisions, from  $0.34$  to  $0.46$  mm. from the ante-

rior extremity of the body. The excretory pore is about  $150\mu$  posterior to this point.

The *females* vary in length from 24 to 44 mm. and in maximum breadth from 0.5 to 0.7 mm. Posteriorly the body is gradually attenuated to end in a bluntly pointed tail. The anus is situated 0.30 to 0.53 mm. from the caudal extremity. The vulva is not salient on the external surface, and must be diligently sought for. Its position oscillates around the middle point of the worm, dividing the body in proportion of 1:0.55 to 1:1.5. The eggs embryonated in utero, with fairly thick, even, walls, measure from  $32$  to  $43.4\mu$  by  $17$  to  $25.3\mu$ . These variations in the size of the eggs and in the relative position of the vulva apply to worms from each of the three hosts from which our material was derived.

The *male*, when full grown, is from 18 to 21 mm. in length with a maximum breadth averaging about 0.66 mm. Among the worms taken from *Mastomys*, however, there was found a male of distinctly diminutive size, measuring 12.5 mm. in length and 0.44 mm. at its widest point. The caudal region of this specimen exhibited the typical characters of the other male specimens and we are consequently constrained to believe that the specimen, while bearing all the adult characters, is mature but not yet grown to full size. The caudal extremity of the male is always tightly coiled ventrally, making it difficult to orient the specimen so as to secure a good view of the ventral surface, but by tedious manipulation and, occasionally, by severing the posterior end, we succeeded in securing ideal preparations of four males. Clearing in hot lacto-phenol enables one to make out all the details of the spicules and to measure these structures with a good degree of accuracy otherwise not obtainable.

In the full grown male the caudal wings are practically symmetrical on both sides. They extend from a point 1.05 mm. from the posterior extremity. They are covered ventrally by serial rows of elongate boss-like thickenings of the cuticle. The alae are supported by 5 pairs of long pedunculate papillae; four pairs are preanal and one postanal. Of the preanal papillae, the first three pairs are almost equidistantly separated, while the fourth pair closely approximates the third. Viewing the worm from the side, one may observe that the papilla sense organs are situated almost on the very edges of the alae. The anus is situated about 0.52 from the end of the body. Ornamenting its right side is an elevated band of cuticle semilunar in shape and carrying more or less sharp serrations on its edge. Within this semilunar area there are two fairly large, sessile papillae in the post-anal position. Towards the

extremity of the ventral surface of the tail is an oval area free from cuticular bosses and displaying, when suitably cleared, ten pairs of relatively minute papillae; three pairs arranged in a triangle and two pairs in tandem series at the base of the tail.

The spicules are unequal and dissimilar. The right, a little wider but considerably shorter than the left, is from 0.515 to 0.61 mm. in length and the average thickness of its fluted shaft is 0.022 mm. The left spicule, which usually takes up a broadly sinuous position, shows considerable variation in its length, being from 1.62 mm. to 2.85 mm. in fully grown specimens. (In the small stunted male specimen mentioned above, the left spicule measured 2.80 mm.) The width of the left spicule averages about  $10\mu$ . A true gubernaculum is not present, but in one specimen a slight hyaline thickening of the wall of the rectum or of the muscles in the neighborhood of the anus, so simulated an accessory piece that it might have been taken for one had no other specimens been examined.

#### AFFINITIES

Until Schulz (1927)<sup>1</sup> described *Arduenna katussi* from various rodents from Southern Russia and Turkestan, only two species, namely *Arduenna strongylina* (Rudolphi, 1819) and *A. dentata* (v. Linstow, 1904) had been attributed to the genus. *A. strongylina* is a fairly common parasite in the stomach of the hog and wild boar and its distribution is apparently coincident with that of its host; on the other hand, *A. dentata* which is also from the hog, has only been recorded from the Orient.

In the accompanying table, the measurements of the taxonomically important organs are given for the three previously described species together with those of *A. africana* described above.

Although the size of the body and of its various organs may be of service in distinguishing *A. dentata*, for the other species, as will be seen from the foregoing table, a consideration of size alone has little, if any, differential value.

The position of the vulva is often difficult to detect without resorting to dissection. Railliet and Henry have questioned the accuracy of von Linstow's determination of the relative position of this organ in *A. dentata*. However, a markedly anterior position of the vulva appears to be one of the chief distinguishing features for *A. katussi*. In the

<sup>1</sup> I am indebted to Dr. N. A. Borodin of this museum for his translation of Schulz's paper from the Russian.

	<i>A. katussi</i> (from Schulz, 1917)		<i>A. strongylina</i> (from Foster, 1912)		<i>A. dentata</i> (from Foster, 1912)		<i>A. africana</i> Sandground	
	♀	♂	♀	♂	♀	♂	♀	♂
<i>Measurements in mms.</i>								
Length	28.5	13.3	16-22	10-15	40-55	25-35	24-40	12.5-21
Max. breadth	0.425	0.24	0.368	0.30-387	1.10	0.7-.8	0.5-.7	0.66
Pharynx	0.114		0.83-0.98		0.11		0.11-0.147	
Oesophagus and relation to total length.	2.58( $\frac{1}{11}$ )	2.58( $\frac{1}{6}$ )	3.1-3.7( $\frac{1}{4}$ )		( $\frac{1}{8.6}$ )		2.3( $\frac{1}{10}$ )	3.17( $\frac{1}{6.3-8.7}$ )
Commencement of cervical alae from antr. end.	0.228	0.152	0.28		—		0.48	
Nerve ring to anterior end	0.266	0.256	0.35		—		ca. 0.34-0.46	
Excretory pore to antr. end	0.387	0.332	0.48		—		ca. 0.5-0.6	
Division of body by vulva	1:8.6		1:1.2		1:3		1:0.55-1:1.6	
Anus to posterior end	0.3		0.21-0.27		—		0.3-.053	
Eggs	.039 x .024		.034-.039 x .020		.039 x .017		.032-.040 x .017-.025	
Left Spicule	1.25		2.24-2.95		3.75-4.23 (0.92)*		1.62-2.8	
Right Spicule	0.311		0.457-.619		0.54-.65 (0.35)*		0.53-.61	

\* measurements of von Linstow (1904)



other species, the position of the vulva vacillates around the middle of the worm, tending towards a definitely posterior position. Our examination of immature worms from *Mastomys* indicates that the variation in the position of the vulva is to a certain extent to be correlated with the size of the individual.

Because of the considerable variations exhibited within the species, it appears that neither the absolute size nor the size relationship that the spicules bear towards each other can be regarded as a specific differential character.

The most significant characters, then, upon which the distinction between the different species in the genus appear to rest, are the secondary sexual characters of the male. The serrated elevation known as the pericloacal crown which forms a complete circle around the cloaca in *A. dentata* distinguishes this species from *A. strongylina* and *A. africana* where it is crescentic or semilunar in shape. A pericloacal crown is neither described nor depicted for *A. katussi*. A similar structure is present in *Streptopharagus baylisi* Ortlepp, 1925. Le Roux (1930) regards this serrated ridge as an artifact not discernable in living material and produced by the pressure of the coverslip on the rather loose cuticle of the male venter. In this view I am unable, however, to concur, since it is a definite structure produced by a peculiar arrangement of cuticular bosses in some species and apparently not in others, and in the species where it occurs it can often be demonstrated without subjecting the region of the venter to any uneven pressure.

The number and distribution pattern of the sessile papillae, or caudal pores as they have sometimes been called in other genera, on the ventral surface of the caudal extremity in the male at present appears to be the most constant specific character available for comparative purposes. Further investigations in other species may, I suspect, show them to be uniformly present in all species. These diminutive papillae have not been described in *A. dentata*, and Foster (1912, p. 14) was unable in his American material to corroborate the presence of the five pairs of terminal caudal papillae depicted by Ciurea (1911) in *A. strongylina* from hogs in Roumania, a difference which reflects either on the accuracy of Foster's observations on this point, or indicates a specific difference in the material examined by these two authors. In addition to the 5 pairs of pedunculate papillae present in all species of the genus, Schulz in *A. katussi* describes an unpaired preanal papilla, a postanal pair of sessile papillae and three single diminutive papillae at the caudal extremity. In *A. africana*, as in *A. strongylina* as depicted by Ciurea, there are five pairs of terminal papillae, but their

topographical arrangement is different and in addition *A. africana* may be distinguished by the possession of a pair of large post-anal papillae.

#### KEY TO THE SPECIES OF ARDUENNA

- |      |   |                       |
|------|---|-----------------------|
| I.   | Pericloacal crown absent; gubernaculum present, vulva markedly anterior ..... | <i>A. katussi</i>     |
|      | Pericloacal crown present; no gubernaculum .....                              | II                    |
| II.  | Pericloacal crown circular; vulva posterior .....                             | <i>A. dentata</i>     |
|      | Pericloacal crown crescentic; vulva near middle .....                         | III                   |
| III. | Postcloacal sessile papillae absent .....                                     | <i>A. strongylina</i> |
|      | Postcloacal sessile papillae present .....                                    | <i>A. africana</i>    |

#### Family PHYSALOPTERIDAE

##### Subfamily Physalopterinae

##### THUBUNEA GRAYIACOLA, sp. nov.

Hosts: *Grayia tholloni* and *Bitis arietans*.

Locality: Ukerewe Island, Tanganyika.

##### THUBUNEA AGAMAE, sp. nov.

Host: *Agama hispida distantis*.

Locality: Lourenco Marques, Mozambique.

The material from the two sources named above differs in such criteria as size, relative position of the vulva in the female and in the pattern of the caudal region in the male. This requires their recognition as separate species. The well-defined genus *Thubunea* is, however, sufficiently homogeneous so that the formal extensive descriptions of the new species is not necessary. Reference to the figures and to the accompanying table, in which are set forth the measurements (in millimetres) of the taxonomically important organs of the two species, should supply all particulars required for their recognition.

The specimens from *Bitis arietans* are all females which, however, could not be distinguished from the females taken from *Grayia tholloni* in the same locality. The material from these two hosts is consequently regarded as belonging to the same species. The genus *Thubunea* has hitherto been recorded only once from the Ophidia [*T. pudica* in *Cerastes vipera* — see Seurat (1914)] and has been con-

sidered as a typically lacertilian form. These two further records of the genus from snakes may call for a change in this view.

<i>Male</i>	<i>Thubunea grayiacola</i>	<i>Thubunea agamae</i>
Length	14-15.1	8.1-9.1
Max. breadth	0.26-0.30	0.2
Pharynx	0.036	0.029
Antr. Oesophagus	0.29	0.18
Entire Oesophagus	2.2-2.31	1.61
Antr. end to cervical papillae	0.255	0.162
Length of Bursa	0.62-0.82	0.37
Breadth of Bursa	0.35	0.28
Spicules	0.072 } (approx.)	0.090 } (approx.)
	0.055 }	0.095 }
Tail	0.37	0.22

*Female*

Length	21-28	14-19
Max. breadth	0.41	0.37
Pharynx	0.045	0.040
Antr. Oesophagus	0.44	0.32
Entire oesophagus	2.93-3.03	2.58-3.10
Antr. end to vulva	3.56-3.80	2.58-2.70
Eggs	0.032-0.036 x 0.023-0.025	0.026-0.029 x 0.021-0.024
Tail	0.181-0.21	0.130

As will be noted, the two species are distinguishable by size. Further the female of *T. grayiacola*, whose vulva is situated some distance behind the end of the oesophagus can be differentiated from *T. agamae* in which the vulva opens either anterior to or at the same level as the oesophageal end.

Seurat, in his description of the type species of the genus, referred to the difficulty of making observations on the very lightly cuticularised spicules of the male. Baylis (1926 and 1930), who has described two further species of the genus, also mentions this difficulty, and on this account was unable to state definitely whether spicules were present in *T. parkeri*. Our experience in this connection was no different. Even when the caudal region of a specimen was accidentally crushed apart by the oil-immersion objective it was difficult to decide where the delicate spicules end and their retractor muscles are attached. In view of this one is compelled to attach less significance than usual to the estimated size of the spicules as a character for the differentiation of

the species and to give greater value to other characters of the region. For the better study and differentiation of the caudal papillae from the surrounding verruciform elevations of the cuticle, by far the best results were secured by heating the worms slowly in lactophenol. On the basis of constant differences in the number and disposition of the

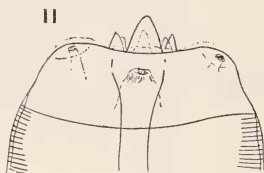


Fig. 11. *Thubunea agamae* n. sp. Cephalic extremity. Median lateral view.

caudal papillae and in the size and shape of the verruciform elevations at the periphery of the ventral pad, *T. grayiacola* and *T. agamae* are readily distinguished. (Cf. figs. 12 and 13).

*Systematic Affinities.* The distinction of the two species dealt with in this paper from *T. pudica* Seurat and *T. parkeri* Baylis may be made

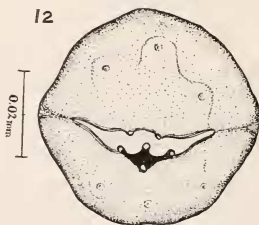


Fig. 12. *Thubunea agamae* n. sp. Cephalic extremity. Frontal view.

on the basis of their smaller eggs and other characters. The only other species to be considered in this connection is *T. asymmetrica* Baylis. The relationship to this species appears to be quite close on account of a similar asymmetric appearance of the lips in both *T. grayiacola* and *T. agamae*, but it may be that such a labial asymmetry is not restricted to the species unit. From an examination of the anterior

extremity of the worms seen in frontal section as well as from the side, it appears that there are two relatively large teeth which arise from the cuticularised pharynx and protrude between the inner surfaces of the lips. These teeth, however, are more closely applied to the smaller, left lip than to the larger right. There are also two more pairs of accessory teeth, the pair on the right lip, being relatively reduced are

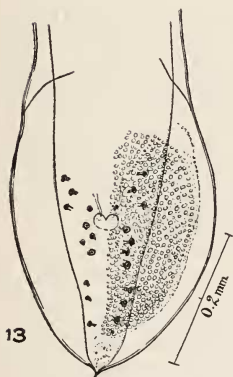


Fig. 13. *Thubunea agamae* n. sp. Caudal extremity of male. Ventral view.

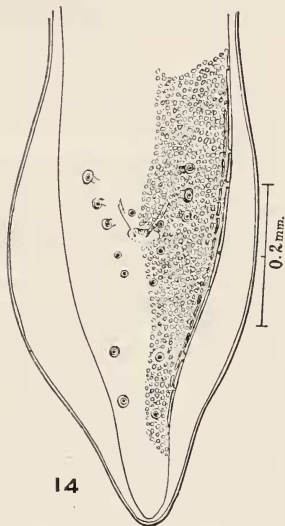


Fig. 14. *Thubunea grayiacola* n. sp. Caudal extremity of male. Ventral view.

less easily seen (figs. 11 and 12). This structure is rather different from that described for *T. asymmetrica* and it is mainly upon this difference that the distinction of *T. agamae* rests.

Since this manuscript was completed and submitted for publication in December, 1930, the publication by Ortlepp (*Jour. S. Afr. Vet. Med. Assn.*, 1931, Vol. 2:128-131) of a new species of *Thubunea*, *T. fitzsimonsi*, from a Kalahari lizard, *Ichnotropis squamulosa*, has come to



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BIRD REMAINS FROM THE OLIGOCENE DEPOSITS OF  
TORRINGTON, WYOMING

BY ALEXANDER WETMORE

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